Space Weather Technical Forecast

Issued on Monday, 29 May 2023 at 13:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1/R2 radio blackouts likely at times throughout. Active electron fluence likely Days 3-4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with no significant flares. There are currently 9 regions on the visible disc. AR3315 (Eki/Beta) is the largest region on the disc but has simplified magnetically. AR3314 (Dai/Beta-Delta) in the northwest also contains a delta spot but is significantly smaller. AR3311 (Eso/Beta-Gamma) is also a region of note being in beta-gamma formation but it is rather long and open and continues to decay. All other regions on the disc are either small or simple.
No Earth-directed CMEs were observed during the period.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 have remained at background to slightly elevated levels close to 400 km/s. Density has been below average (<5 ppcc). The total interplanetary magnetic field strength has been weak below 6 nT. The north-south component has weakly fluctuated between +5/-5 nT. The phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2), after an Unsettled (Kp3) interval between 28/1200-1500 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) was also at background levels. The associated 24 hour fluence was Active (above 1e8 integrated pfu) at first but declined through the period from 1.55e8 to 5.62e6 integrated pfu. Electron fluence observed at 29/0000UTC was 2.32e7 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low or Moderate. There is a slight chance of X-class flaring throughout.

Solar Wind / Geomagnetic Activity: A weak CME that left the Sun on 25 May may give a glancing blow at Earth on Day 1 (29 May). A second CME from an eruption on 26 May could give a glancing blow at Earth late on the Day 2 (30 May) or on Day 3 (31 May). However, both are likely to pass Earth without effect. A High Speed Stream from CH08/+ may connect with Earth later on Day 4 (1st June). Solar winds are likely to remain at background or slightly elevated levels, with a chance of becoming elevated later on Day 4 should the HSS connect with Earth. Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a chance of Active, and slight chance G1/Minor Storms through the period due to possible CME impacts or the CH HSS on Day 4.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. There is a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to remain below the high threshold on Day 1 (29th May) but with an increasing chance of reaching High levels during the diurnal maximum through the period. The possible CME arrivals and high speed stream connections could generate enough geomagnetic activity reduce electron counts but with limited confidence. Electron fluence values may return to above the Active (1e8 integrated pfu) threshold by Day 3 or 4 (31st May/ 1st June), but there is low confidence later in the period due to the uncertainty of modifying factors.

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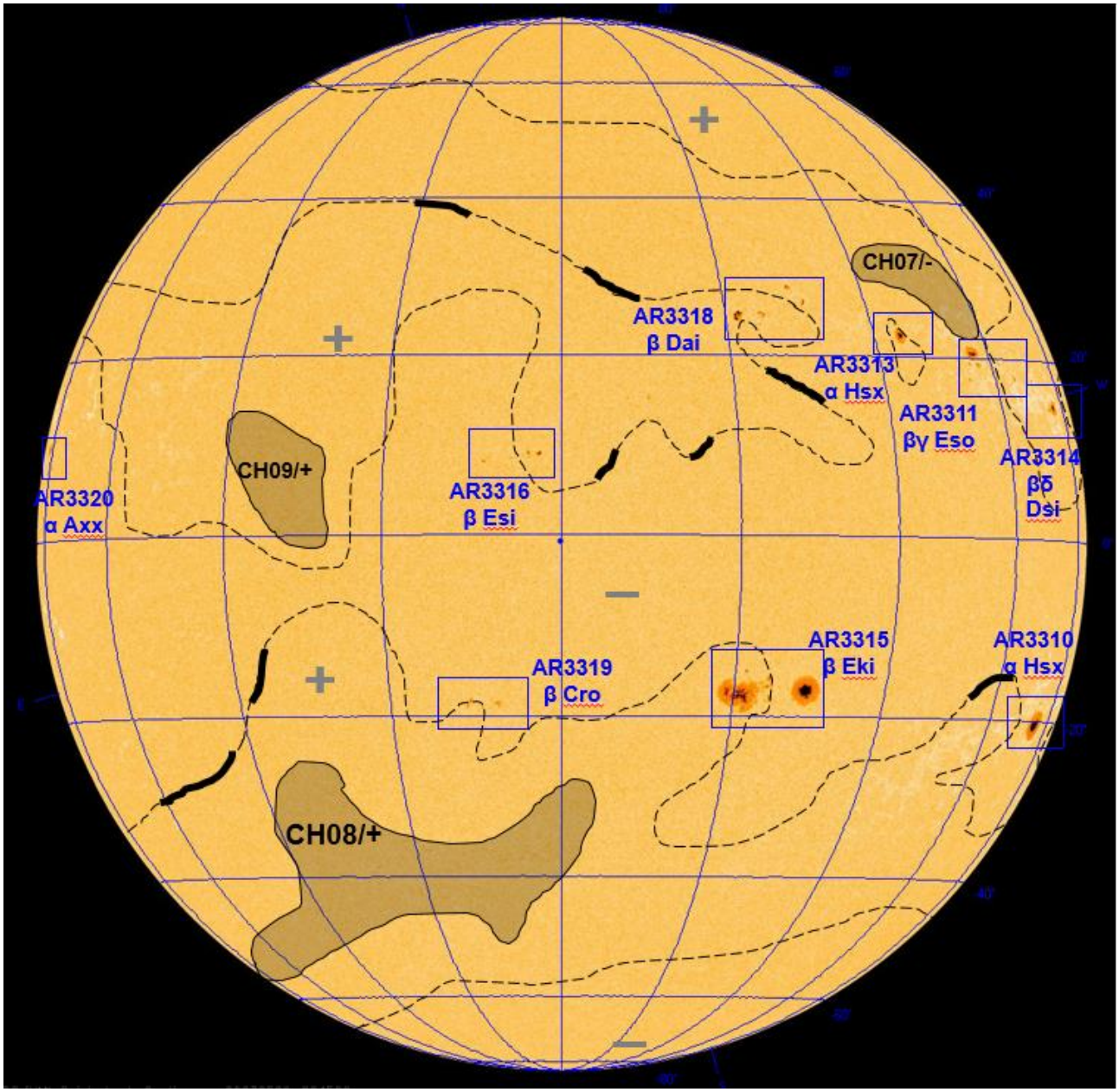
Figure 1. Solar Analysis Valid 29/0700 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs have been observed in the past 24-hours. However, a number of Enlil ensemble members support the arrival of a weak CME that left the Sun on 25 May giving a glancing blow at Earth on Day 1 (29 May). A second CME from an eruption on 26 May could give a glancing blow at Earth late on the Day 2 (30 May) or on Day 3 (31 May), although much of this second feature is directed southward.

Solar winds are likely to initially remain slightly elevated but close to ambient levels due to the slight but waning enhancement from a recent HSS. Persistence would suggest that the high speed stream from CH07/- is likely to connect on Day 1, following the pattern of the previous rotation. CH07/- is of a similar shape and size to the last rotation, which would support this aspect of the forecast and suggests peak speeds of around 500km/s. On Day 3, solar winds are likely to return to ambient levels as this enhancement fades.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a chance of Active, and slight chance G1/Minor Storms through the period due to possible CME impacts or the CH HSS on Day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

Figure 2: BGS Kp

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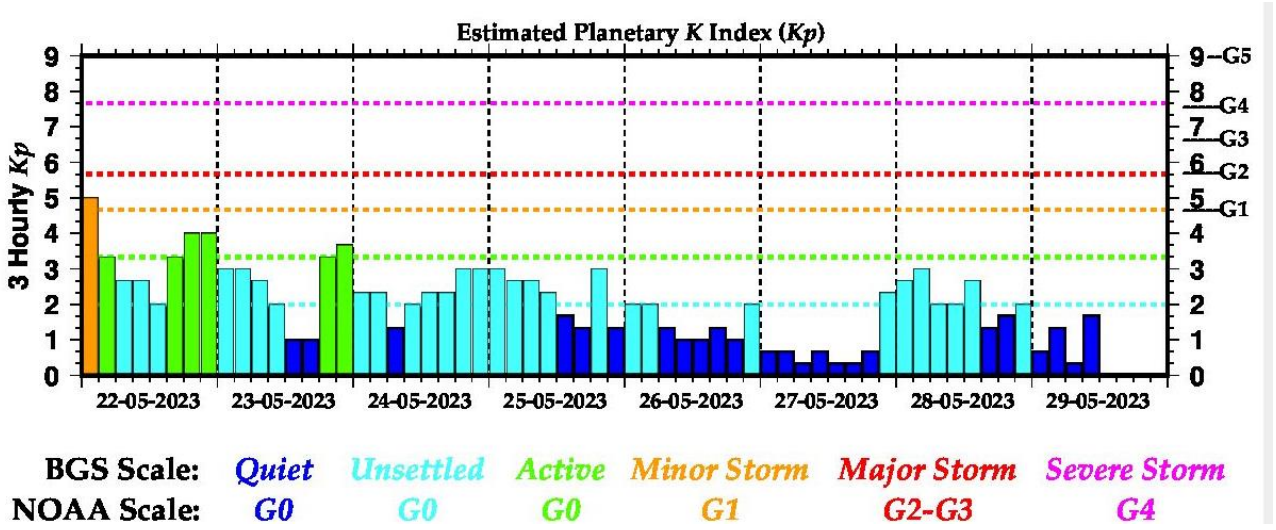

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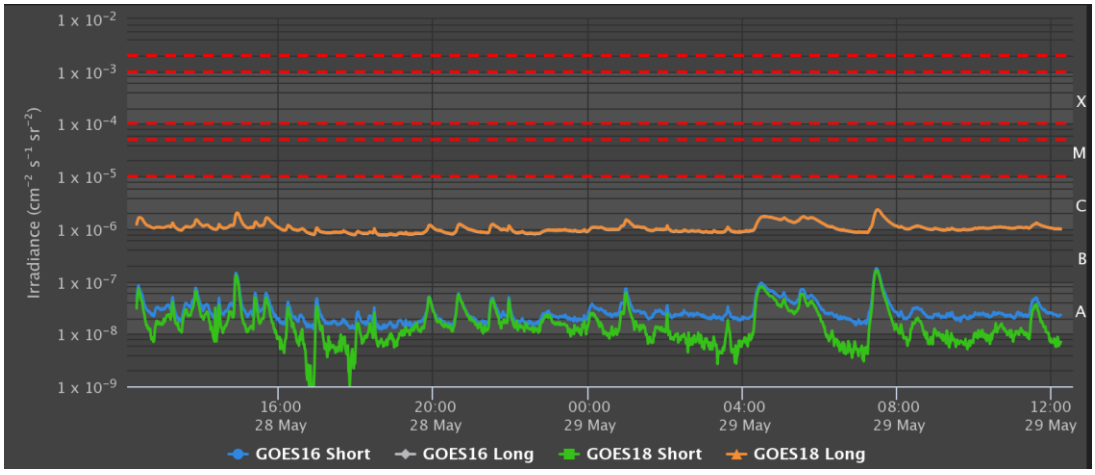
Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours, with no noteworthy flares.
There are currently 9 numbered and 3 unnumbered sunspot regions on the visible disc. AR3315 (Eki/Beta) remains the largest region but has lost some magnetic complexity and decreased a little in size. AR3314 (Dsi/Beta-Delta) in the northwest may have retained a minor delta spot, however viewing angle of the region reduces confidence. AR3311 (Eso/Beta-Gamma) is also a region of note being in beta-gamma formation but it is rather long and open. The unnumbered region in the northwest continues to develop with new intermediate spots emerging. AR3312 has decayed to plage.
All other regions on the disc are either small or simple and have displayed little change.
AR3320 is rotating across the eastern limb, as it rotates further onto the disc the improved viewing angle will result in more confident classification.
Isolated M-class flares are considered likely through the forecast period, mainly due to the complex regions in the western hemisphere and there is a slight chance of an X-flare.
Several regions, some of which may have been responsible for significant activity as they tracked across the far side, are due to rotate onto the eastern limb over the next few days and are expected to lead to an increase in solar activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES16 X-Ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels. There is a slight chance of S1/Minor Radiation Storming, should any larger flares occur, with AR3315 the most likely source region as it transits the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at Background to Moderate levels. Through the period it is increasingly likely to return to High levels during the diurnal maximum, in the absence of any modifying factors, particularly later in the forecast. The most likely source of any geomagnetic activity is from two CMEs on Day 1 (29 May) and Days 2-3 (30-31 May), although both these are only likely to glance the Earth at most, resulting in limited geomagnetic activity. There's a chance we may see a Coronal Hole High Speed Stream later on day 4 (1st June).

There is a chance that associated 24 hour fluence may recover to above Active (1e8 integrated pfu) by Day 3 or 4 (31 May/1 June). However, there is low confidence in the forecast, with REFM showing a large spread in possible fluence values. The increase in probabilities later in the forecast reflects the uncertainty with geomagnetic activity and the charging and relaxing of electron belts during the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	20	30	40	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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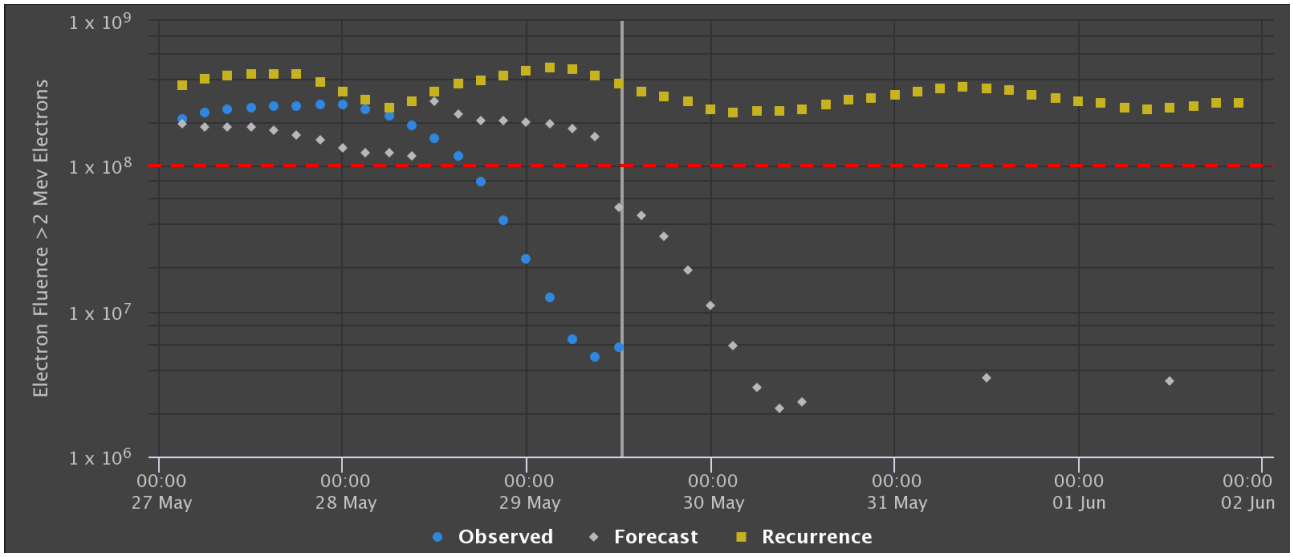
Figure 4: MOSWOC REF Model



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